



Project Summary

Compendium of Selected Methods for Sampling and Analysis at Geothermal Facilities

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The establishment of generally accepted methods for characterizing geothermal emissions has been hampered by the independent natures of both geothermal industrial development and sampling/analysis procedures, despite three workshops on the latter (Las Vegas 1975, 1977, 1980). An independent study of the field has resulted in a compilation of the best methods for sampling, preservation, and analysis of potential pollutants from geothermally fueled electric power plants. These methods have been selected as the most usable over the range of application commonly experienced in the various geothermal plant sample locations. In addition to plant and well piping, techniques for sampling cooling towers, ambient gases, solids, surface, and subsurface waters are described. Emphasis is placed on the use of sampling probes to extract samples from heterogeneous flows. Where possible, analytical methods capable of reaching aquatic life criteria sensitivities are described. This series of techniques is best if applied or directly monitored by one person to optimize consistent use and interpretation. Certain sampling points, constituents and phases of plant operation are more amenable to quality assurance improvement in the emission measurements than others and are so identified.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Las Vegas, NV, to

announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Purpose

The purpose of this manual is to provide direction to persons involved in characterizing flows and locations that may generate emissions from a geothermal power plant. The specific goal of this document is to establish the best methods for geothermal situations, and their functional equivalents, while describing enough of the problems and variables to instruct the user about practical problems.

Contents

The techniques detailed in this manual address the sampling, preservation, and analysis of inorganic constituents of geothermal fluids which may be of environmental concern. The techniques are described to permit sampling at all known emission locations at geothermal plants as well as at the input to the plant. Although input to the plant would not represent an emission point, the sampling methods included here will permit a constituent mass balance through the plant to be calculated. Methods for sampling ground water and ambient air are described in less detail, since these techniques are not specific or unique to geothermal facilities.

The constituents and parameters of possible environmental concern that are addressed in the manual include:

- general—alkalinity, specific conductance, total dissolved solids, pH
- anions—chloride, fluoride, nitrate, sulfate, sulfide
- metals—aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, selenium, silica, silver, zinc
- gases—radon, ammonia, hydrogen sulfide

Where appropriate, possible analytical methods capable of measuring concentrations down to the aquatic life standards are described in order to cover the broadest range of applications.

Sampling techniques and equipment are described for geothermal wells, piping for both binary and steam cycle plants, cooling towers, ponds, streams, sludge deposits, and fugitive and ambient gases, as well as locations where two-phase geothermal flow occurs. The necessity for using a sample probe inserted into the main flow is stressed along with the appropriate use of separators, condensers, and depressurizing valves. Groundwater sampling is treated separately, since the techniques are not exclusive to the geothermal industry. It is recommended that a site-specific evaluation be conducted before initiating an extensive program. Current regulations regarding injection monitoring for geothermal plants are briefly referenced.

The preservation guidelines peculiar to geothermal samples are outlined and include holding time, containment mate-

rials, chemical treatment, and equipment. The need to acidify, dilute, and filter sample fractions in the field is stressed because of the supersaturated nature of some constituents.

Analytical methods were selected based on a combination of analytical performance, flexibility, ease of operation, and availability. The stepwise procedures are described in the text for each element along with a listing of other usable methods and an indication of particular samples for which they are most suited. As a general rule, for metal analyses, the laboratory should eliminate interferences in a particular geothermal brine sample by using either matrix-matched standards or through a standard addition calibration. Recommended analytical methods for most geothermal samples are identified by title below.

Titration: alkalinity, chloride, sulfide

Specific Meter: specific conductance

Gravimetry: total dissolved solids

Potentiometry: pH

Selective Ion Exchange: ammonia, fluoride (preceded by distillation)

Colorimetric: fluoride (preceded by distillation), silica

Turbidimetric: sulfate

Inductively Coupled Plasma: aluminum, boron

Atomic Absorption, Gaseous Hydride: arsenic, selenium

Atomic Absorption, Direct: boron, copper, lithium, manganese, molybdenum

Atomic Absorption, Graphite Furnace: cadmium, chromium, lead, silver, zinc

Atomic Absorption, Cold Vapor: mercury

Alpha Counter: radon

Chemiluminescence: ammonia (ambient)

Flame Photometry: hydrogen sulfide (ambient)

The section on quality assurance (QA) includes a method of arriving at the most efficient QA balance between field and laboratory operations for a particular plant. The sensitivity of various contaminants and sample locations to QA improvement efforts is estimated for geothermal situations. It is recommended that the entire monitoring effort, from sampling to analysis to interpretation, be under the direction of one person.

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The complete report, entitled "Compendium of Selected Methods for Sampling and Analysis at Geothermal Facilities," (Order No. PB 84-199 926; Cost: \$17.50, subject to change) will be available only from:

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